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Analysis

Lead markets in 2nd generation biofuels for aviation: A comparison of Germany, Brazil and the USA

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ABSTRACT

Biofuels are the first feasible option for greenhouse gas emission reduction in aviation. This paper uses the lead markets framework to consider potential advantages in process plant required to produce 2nd generation biofuels for aviation. Germany and Brazil both have the potential to develop a lead market. They are active in technology development and have a demand interest through a significant aircraft and airline industry. The USA has also been found to be a country with a very high lead market potential. Since the technology is at a demonstration stage, market information for the assessment of lead market advantages is not available. However, there are a range of indicators of firm activity and market potential that can be combined to make a general assessment. For this case, it is necessary for the lead market framework to be extended to consider international technology networks instead of a national lead market.

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1. Introduction

Aviation has been one of the fastest growing economic sectors and GHG (greenhouse gas) emissions from aviation are now a major policy issue (Button, 2008; OECD, 2010; Anger and Köhler, 2010). Although fuel costs are a large proportion of operational costs and improving energy efficiency of aircraft is a main objective of technological development, the rapid growth in activity has more than

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outweighed improvements in recent years (Anger and Köhler, 2014). This has been recognised in discussions about environmental policy for aviation. In 2007, the CEO of International Air Transport Association (IATA) called for a zero emissions future for the air transport industry (IATA, 2007). In 2009, the European Parliament decided on the inclusion of aviation in the EU ETS from 2012 (Directive 2008/101/EC, 2009).[1]

The industry is developing responses to this policy pressure. There are technologies that could improve energy efficiency, for example open rotor engines and blended wing airframes (Sgouridis et al., 2011; Parker and Lathoud, 2010; QINETIQ, 2008). These have been studied extensively, so the fundamental knowledge of these technologies is already available. However, the application to a next generation airliner will be difficult and expensive to develop (Köhler, 2014). Furthermore, the long lifetime of aircraft (around 22 years on average, see e.g. Köhler, 2011) implies that new technology is slow to diffuse through the global aircraft fleet. The industry is also considering alternative fuels such as H_2, for which concepts are also available. These possibilities could only deliver large emissions reductions in the long run – 2050 and beyond.

The technology which is closest to market diffusion is the use of biofuels as an alternative fuel. According to the International Air Transport Association (2010, p. 47) requirements for aviation biofuels are:

- "*[To] Offer net carbon reductions over their lifecycle*
- *[. . .] not [to] compete with fresh water requirements and food production*
- *[. . .] not [to] cause deforestation or other environmental impacts such as biodiversity loss*"

While there are debates about the actual carbon neutrality of biofuels, the literature finds a considerable potential for CO_2 mitigation through global production of biofuels in the medium to long term from 2030 to 2050 (Kahn Ribeiro et al., 2007; Cornelissen et al., 2012). In this debate, 2nd generation biofuels[2] are recognised as being necessary for a satisfactory environmental performance compared to 1st generation biofuels (E4Tech, 2009), while 3rd generation biofuels are still at the laboratory stage of development. 2nd generation biofuels can be 'Fischer-Tropsch Synthetic Paraffinic Kerosene' derived from Biomass to Liquid (BtL) processes or 'Hydrotreated Renewable Jet' produced as 'Hydroprocessed Esters and Fatty Acids' (HEFA) (European Commission, 2011b). Both fuels are already certified to be used in a 50% blend with standard fossil jet fuel by ASTM (International Air Transport Association, 2011b). As both fuels are pure hydrocarbons, they can theoretically be used in any mixing ratio with each other and with conventional fossil jet fuel. Therefore, biofuels could offer a much more rapid mitigation potential than the technologies mentioned above, because they can be used in current engines and aircraft systems.

There is a considerable literature on mitigation technologies and strategies (Kivits et al., 2010; Parker and Lathoud, 2010; Lee and Mo, 2011; Sgouridis et al., 2011), but there are only a few studies applying the concepts of eco-innovation in this industry (Leduc et al., 2010; Thedieck, 2012). This paper considers the possibilities for lead markets in aviation biofuels to develop (Porter, 1986; Bartlett and Ghoshal, 1990; Beise, 2004). The idea is that for some innovations that are developed in a particular regional (national) market, there is the possibility that the technology may diffuse internationally. The lead market in which the technology was developed may then give its participants a competitive advantage which enables them to play a dominant role in international markets as they develop.

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[1] In fact, in 2012 flights into and out of Europe operated in 2010, 2011, and 2012 have been proposed by the European Commission to be exempted to provide negotiation time for the ICAO General Assembly in autumn 2013, although the legislation continued to apply to all flights within and between the 30 European countries in the EU ETS (COM, 2012).

[2] We use the definition of Carriquiry et al. (2013): 1st generation biofuels are "....those mainly based on sugars, grains, or seeds, and generally requiring relatively simple processing to produce the fuel.....". 2nd generation biofuels are "generally made from non-edible lignocellulosic biomass, including residues of crops or forestry production (corn cobs, rice husks, forest thinning, sawdust, etc.), and whole plant biomass (e.g. energy crops such as switchgrass, poplar, and other fast growing trees and grasses). Biofuels obtained from vegetable oils produced from sources that do not directly compete with crops for high quality land (e.g., jatropha......) can also be labelled as second-generation biofuels." Carriquiry et al. (2013) p. 3. 3rd generation biofuels are produced by extracting oil from algae.

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